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PRESTRESSED SCAFFOLDING SYSTEM

FIELD OF THE INVENTION

The present invention relates to a scaffolding system that is temporarily placed underground for preventing the collapse of excavated earth while an underground structure is built and, more particularly, to a prestressed scaffolding system using tendons with vertical piles (e.g., H-beams) and horizontal piles (e.g., wales), whereby the number of struts supporting the vertical piles is considerably reduced.

BACKGROUND OF THE INVENTION

It is well known that excavation work for constructing a subway or a basement of a building is started by excavating holes into the ground surface to a designed depth on the basis of technical drawings, and then vertical piles are installed in the excavated holes. After the installation of the vertical piles, excavation is partially carried out, and then main girders and cover plates are placed. After the placement of the cover plates, additional works are repeatedly performed by alternately excavating and placing the struts.

Accordingly, in order to design a scaffolding system, the earth pressure on each excavation level and load applied onto the struts are repeatedly calculated, thereby enabling to design struts that can withstand the maximum load applied to the beams. As a result, a large number of struts are required. In most cases, the struts

are closely arranged, e.g., within intervals of approximately 2-3m, for primarily obstructing the delivery of construction materials in a working area, the transportation of heavy equipments, and performance of the construction works. The struts also give rise to a severe impediment to a molding or steel work when the main structure is built. For example, a plurality of holes is unavoidably formed in the main structure, such that the finished underground structure is subject to penetration of water.

In the conventional scaffolding system, steel H-piles are used as the vertical piles, while concrete piles for filling concrete into the excavated holes may be used as the vertical piles instead of using steel H-piles. Additionally, the steel piles and the concrete piles may be simultaneously used, or sheet piles may be used. However, the basic principle of supporting the load of excavated earth by making holes in the ground and then forming a wall by piles is almost identical to that of the aforementioned works. Preflexed beams may also be used as the vertical piles, and the H-piles may be attached to the sheet piles to strengthen the sheet piles.

The earth anchor system is used for supporting steel piles in the scaffolding system for constructing underground structures in place of systems using the aforesaid struts. According to this system, inclined holes are drilled into the ground behind the piles, tendons or high strength steel bars are inserted into the drilled holes, ends of the inserted bars are anchored by a mechanical method or a chemical method such as epoxy or cement grouting, and then the bars are tensioned and fixed to the steel piles. This system has an advantage in that the inner space of the scaffolding system is very

spacious, allowing the earth works and the support works to be easily performed. On the other hand, there is a disadvantage in the system in that the works have to be placed in the vicinity of private properties when this system is applied in a crowded city, thus causing a lot of civil appeals from the neighbors. The high cost of the construction is another disadvantage.

Korean Utility Model Registration No. 258949 discloses a method using truss for removing struts, which pass across the excavated space of the scaffolding system. This method is expected to be applied to a case where the depth of the excavated ground is relatively shallow. H-beams are doubly placed in a grid-type near the earth surface. The H-beams are reinforced with vertical beams and inclined beams so that the earth pressure is supported by two floor trusses placed at the upper portion of the scaffolding system. This method has been proposed to overcome difficulties in excavating and constructing the structure, which occur due to the many struts of the scaffolding system for supporting the ground. Consequently, this method is useful for a construction to contain a wide structure at the bottom and a narrow structure at the top of the excavated ground.

Korean Patent No. 188465, Korean Utility Model Registration No. 247053, and Japanese Patent 837994 disclose a method for reinforcing a wale using prestressing. In this method, an additional wale is placed on top of the existing wale for tensioning the tendon and expanding the distance between the struts. This method may be performed by using an additional wale or by reinforcing the flange of existing

H-beams. These two methods are expected to be effective in increasing the distance between the struts. However, since the tendon is linearly disposed, a constant support bending moment occurs, which is different from the parabola-shaped moment distribution generated on the wale by the earth pressure. Different moments and the distribution thereof in relation to the load restrict the length of the reinforced wale.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide a safe and effective method of greatly reducing or removing the number of struts, which interfere in structure work and cause an increase in construction costs, thereby obtaining an underground construction space and minimizing construction costs.

In one preferred embodiment of the present invention, a prestressed scaffolding system for supporting the excavated earth retaining wall by forming a polygonal closed section comprises a prestressed wale comprising a plurality of triangular tendon supports in the middle portion, a tendon-anchoring unit at both ends of the wale, and a connecting brace for connecting the supports and the tendon-anchoring unit. A strut is constituted by a truss or a plurality of H-beams or an H-beam having a large cross section and strengthened for supporting the tendon-anchoring unit.

The triangular tendon support is constituted by a vertical member and an inclined member, or only by vertical members, or only by inclined members for

forming a triangle and supporting the wale. The triangular tendon support is supported and connected by an intermediate pile and a support beam for the tendon support.

The tendon-anchoring unit fastens a tendon and couples with the wale for applying the compression force and also couples with the inclined or vertical member for supporting the generated force.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature and objects of the present invention, reference should be made to the following detailed description with the accompanying drawings, in which:

FIG. 1 is a plan view of a scaffolding system applied to a closed section according to an embodiment of the present invention;

FIG. 2 is a plan view of a scaffolding system applied to another closed section according to an embodiment of the present invention;

FIG. 3 is a cross-sectional view illustrating a scaffolding system applied to a closed section according to an embodiment of the present invention;

FIG. 4 is a cross-sectional view of a scaffolding system applied to one direction of a cross-section according to an embodiment of the present invention;

FIG. 5 is a cross-sectional view illustrating a scaffolding system applied to one direction of a cross-section according to an embodiment of the present invention;

FIGS. 6a to 6d are detailed views of a tendon support used in the scaffolding

system according to an embodiment of the present invention;

FIGS. 7a and 7b are detailed views of a corner tendon-anchoring unit used in the scaffolding system according to an embodiment of the present invention;

FIGS. 8a to 8d are detailed views of a horizontal tendon-anchoring unit used in the scaffolding system according to an embodiment of the present invention; and

FIG. 9 is a detailed view of a vertical tendon-anchoring unit used in the scaffolding system according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will now be described in detail with reference to the attached drawings.

FIG. 1 is a plan view of the present invention applied to a closed section of an architecture site. According to an exemplary embodiment of the present invention, a prestressed wale 1 is disposed at four lateral sides of the closed section. A strut 3 made by a truss is placed at four corners and supports the wale. A conventional corner support beam 5 is situated behind the strut. The prestressed wale 1 of each lateral side includes three triangular tendon supports 12, a triangular anchoring unit 13, and a connecting brace 10 for connecting the triangular tendon supports 12 and the triangular anchoring unit 13. An intermediate pile 23 is equipped to support the triangular tendon supports 12, and a support beam for the tendon support 16 is fixed at the intermediate pile 23 by, for example, a bolt or welding. The support beam for the

tendon support 16 supports the triangular tendon supports 12 during the installation of the scaffolding system. The triangular tendon supports 12 and the support beam for the tendon support 16 are connected via a U-bolt in order to prevent a vertical buckling which may occur in the event of prestressing, carried out after the assembly work of the scaffolding system.

The truss strut 3 of each corner is positioned between two triangular anchoring units 13 to transmit the compression force of the anchoring units. The truss structure of the embodiment of the present invention may be substituted by, for example, an H-shaped steel having a large cross section, a plurality of H-shaped steels, or the like, as long as the structure can withstand high compression force. The constructional method of the corner support beam 5 behind the truss strut 3 is identical to that of the conventional system and illustrated in the drawing for explaining the present invention. The element numeral 60 is a tendon.

The configuration of FIG 2 may be used when the excavating plane is small. A corner anchoring unit 14 substitutes the conventional corner support beam 5 and truss strut 3 of FIG. 1. A T-shaped connecting brace 11 is used where the interval between the prestressed wale 1 and the corner anchoring unit is narrow. The rest of the figures and methods for carrying out the construction work are identical to that of FIG. 1.

FIG 3 is a cross-sectional view of FIGS. 1 and 2 and illustrates a horizontal prestressed scaffolding system 2 and main structure 7 according to an embodiment of

the present invention. Unlike the conventional method, no equipment interferes the middle portion of the system, and a wale 25 is arranged on four stages along the depth of the excavated underground. A soldier pile 22 is located at a distal external wall in a conventional way, and the wale 25 is mounted to support the soldier pile 22. The support beam for the tendon support 16 and intermediate pile 23 are also illustrated in the drawing.

FIG 4, a cross-sectional view of a scaffolding system for a subway, includes a main structure 8, vertical prestressed scaffolding system 6, and horizontal prestressed scaffolding system 2. The horizontal prestressed scaffolding system 2 illustrated at an upper portion of the drawing is identical in its figure and construction method to that of the embodiment of FIG. 2, and thus, explanation of this system will be omitted. However, the vertical prestressed scaffolding system 6 illustrated at a lower portion of the drawing is supported at one side by a floor slab 9 of the main structure after the slab is hardened. The other side of the system 6 is supported by a conventional typical strut 26.

The vertical prestressed scaffolding system is useful when the main structure is long such as a subway. In the vertical prestressed scaffolding system, a vertical H-beam 19 is inserted from behind the pre-installed wale 25, and a short support 18 is attached to the opposite side of the wale 25 for supporting the tension of the tendon 60. The tendon is placed at both ends of the H-beam 19 and is fixed to a separate tendon-anchoring unit 20, which is pre-coupled with the vertical H-beam. Thus, the

anchoring unit of the lower end of the vertical prestressed scaffolding system is configured to be supported by the hardened concrete slab 9 of the main structure, while the anchoring unit of the upper end is supported by the typical strut 26. The element numeral 24 is an earth retaining plate.

FIG. 5 is a plan view of FIG. 4 and is used when the excavating plane is long, e.g., a subway or a channel construction. The prestressed wale 1 is arranged along both lateral sides, and the truss strut 3 is located at each place where the tendon of the prestressed wale is fixed. The configuration of the prestressed wale is identical to the wale of the closed-section of FIG. 1, and thus, further explanation will be omitted.

The enlarged portion of the drawing illustrates the relative location of H-beam 19 in relation to the soldier piles 22, in which the H-beam 19 for the vertical prestressed scaffolding system described in FIG. 4 is installed between the existing soldier piles 22. In the vertical prestressed scaffolding system, the earth retaining plate 24 should be mounted at a flange behind the existing vertical pile to thereby allow the installation of the H-beam of the vertical prestressed scaffolding system. Provided that the vertical pile is a sheet pile 21 in place of the soldier pile 22, the vertical H-beam 19 is inserted into an empty space between the sheet pile 21 and the wale 25.

FIGS. 6a to 6d illustrate various shapes and sizes of the triangular tendon support utilized in the embodiments of the prestressed scaffolding system of the present invention. The triangular tendon support is provided with a vertical member

32 and an inclined member 33 and is configured to reduce the number of support points 31 being in contact with the tendon. The triangular tendon support is also configured to support a wale 30 having a long length. When the compression force is applied on the support point 31 making contact with the tendon, the force functions to support the long wale 30 via the vertical member 32 and inclined member 33.

In FIG. 6a, two inclined members are welded or connected by a bolt (not shown) to thereby form an isosceles triangle and support the wale 30 having a short length. FIG. 6b is a second embodiment of the present invention and illustrates a pair of inclined members 33 connected to each other at a 45 degree angle extended laterally from the vertical member 32. The inclined and vertical members are all connected to the wale 30 by, for example, a bolt or welding. According to a third embodiment in relation to the case that the length of the wale 30 is long, two pairs of inclined members 33 of FIG. 6c are connected to both lateral sides of the vertical member 32, respectively. A plurality of vertical members and inclined members are used in FIG. 6d for supporting the long wale 30. The structure of the triangular tendon support is not limited to the embodiments of the present invention, and thus, may be configured to form a triangle and support the wale by using the vertical member and inclined member, or only by vertical members, or only by inclined members.

FIGS. 7a and 7b are detailed views of the corner anchoring unit 14 of FIG. 2 that are designed to connect a wale 35 of the corner via reinforcing members 36 to thereby secure the tendon 60. That is, when the tendon 60, which is used for

constructing the prestressed scaffolding system, passes through the reinforcing member 36 of the anchoring unit, the tendon is tensioned by a hydraulic jack 70. The tensioned tendon is then fixed by an anchoring unit 71, which anchors the tendon. The force pulled via the tendon transmits the compression force to an adjacent wale (not shown) via a length adjusting unit 72, e.g., a precedent load jack or a screw jack. As another embodiment of the present invention, the configuration of FIG. 7b is adapted to anchor the tendon only by a reinforcing member 38 without a gusset plate. The figures of the above embodiments may be varied in the scope of the basic concept and function of the present invention. The reference numeral 39 refers to an inlet of the anchoring unit.

FIGS. 8a to 8d illustrate various anchoring units of the horizontal prestressed wale. FIG. 8a illustrates a small anchoring unit used when a small amount of tension is applied thereto. The tendon 60 supporting a wale 41 is supported by an inclined brace 43 or a vertical brace 44. The anchoring unit is formed with holes, thereby the inclined brace 43 or vertical brace 44 may be inserted into the anchoring unit through the holes as illustrated in the drawing, or may protrude out (not shown). The inlet 39 of the anchoring unit may preferably be formed in a curved shape in consideration of the flexibility of the tendon. The tendon is fixed via the tendon-anchoring unit 73 at an opposite side of the inlet 39. Further, the length adjusting unit 72 (e.g., precedent load jack or screw jack) is equipped to add the compression force to the corner support beam 5 after the tendon is tensioned.

FIG. 8b illustrates an anchoring unit having an additional wale 42 for strengthening the wale in a case where the wale 41 gets lengthened and the compression force applied on the wale greatly increases thereby. FIG. 8b is identical to FIG. 8a in that the curve-shaped inlet 39 is formed where the tendon 60 supporting the wale 42 is inserted into the anchoring unit, and the tendon-anchoring unit 73 is placed oppositely from the inlet 39. The difference from FIG. 8a is that the inclined brace 43 for supporting the anchoring unit is doubly placed to withstand the increased compression force and earth pressure. In addition, when the compression force is applied on the double wale, the force may differently be applied on each wale, and thus the compression force between the two wales is intended to be equally adjusted by using the screw jack 72 of the high load.

FIG. 8c illustrates the triangular anchoring unit 13 of FIG. 1 configured to secure the tendon 60, which supports the wale 41, via the tendon-anchoring unit 73. FIG. 8c is also configured to transmit the load to the truss strut 3 supporting the triangular anchoring unit 13. In the triangular anchoring unit, an inclined member 47 of H-shaped steel is disposed to form an isosceles triangle to withstand the load applied on the unit. An apex at which these members contact each other is enhanced by an appropriate gusset plate 46. A screw jack 74 is equipped to adjust the compression force of the double wale, and the precedent load jack 72 is equipped to add the compression force to the corner support beam 5. The screw jack 74 is further connected with the truss strut, which supports the entire anchoring unit. A hydraulic

jack 75 is provided to add a great amount of compression force between the anchoring unit and the truss strut. That is, after the tendon is tensioned via the hydraulic jack 70, the hydraulic jack 75 applies a compression force to the truss strut 3.

FIG. 8d shows an anchoring unit used for the scaffolding system illustrated in FIG. 4. The tendon 60 for supporting the wale 41 is tensioned via the hydraulic jack 70 and then secured by the tendon-anchoring unit 73. The tendon is designed to pass through the inclined member 47 at its inlet portion. The truss strut 3 may be connected with the anchoring unit by the screw jack 74 and hydraulic jack 75, or may directly be connected without the aid of these members. The proper gusset plate 46 is mounted for withstanding high compression force between a vertical member and a horizontal member 48, which connects both sides of the anchoring unit. Since the member receives only the prestressing force and the compression force is small, a single wale is illustrated in the drawing. However, a double wale may preferably be used depending on the case.

FIG. 9 is a detailed view of the anchoring unit 20 for the vertical prestressed scaffolding system 6 illustrated in FIG. 4. Similar to the embodiment of FIG. 4, the slab of the existing structure and intermediate strut are used as supports, and an H-beam is inserted from behind the built wale. A short support is attached to the front of the wale and the tendon fixed to the anchoring unit of both ends of the H-beam is supported by the tendon support. This method is for a vertical prestressed scaffolding system, which supports a channel-type excavating surface. In particular, the screw

jack or precedent load jack 72, connected with the horizontal strut 26, is coupled with the anchoring unit 20. If the anchoring unit 20 is placed at a lower end of the scaffolding system, the anchoring unit 20 can directly contact the existing slab (not shown) instead of the strut 26. The vertical H-beam is coupled to the anchoring unit by being inserted into a vertical hole 50. This contact or coupling part may be firmly connected by, for example, welding or a bolt, preferably by a bolt for facilitating the disassembly of the members. Once the tendon 60 for supporting the vertical H-beam is inserted into the anchoring unit, the tendon is fixed by the tendon-anchoring unit 73 at an opposite side of the anchoring unit. Accordingly, this anchoring unit is used in the vertical prestressed scaffolding system, wherein the wale or the vertical beam is removably manufactured.

As apparent from the foregoing, there is an advantage in the prestressed scaffolding system of the present invention in that vertical piles or horizontal beams are prestressed by using a plurality of supports, anchoring units, and tendons. The number of struts and intermediate piles, which caused serious obstacles in carrying out conventional constructional works, is considerably reduced.

There is another advantage in that the excavation and scaffolding system together with the construction cost are remarkably improved.

Also, the formation of holes in the structure, which is inevitable in the conventional scaffolding system, is effectively eliminated, thus facilitating the steel reinforcing works and molding works, reducing the construction period and greatly

improving the water-tightness and durability of the finished structure.